US009123003B2

(12) **United States Patent**
Klein et al.

(10) **Patent No.: US 9,123,003 B2**
(45) **Date of Patent: Sep. 1, 2015**

(54) **TOPOLOGIES CORRESPONDING TO MODELS FOR HIERARCHY OF NODES**

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(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 449 days.

(21) Appl. No.: **13/161,381**

(22) Filed: **Jun. 15, 2011**

(65) **Prior Publication Data**

US 2012/0323814 A1 Dec. 20, 2012

(51) **Int. Cl.**
G06Q 10/00 (2012.01)
G06Q 10/06 (2012.01)

(52) **U.S. Cl.**
CPC ***G06Q 10/06*** (2013.01); ***G06Q 10/067*** (2013.01)

(58) **Field of Classification Search**
CPC G06F 17/30554
USPC 705/7.11–7.42
See application file for complete search history.

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(57) **ABSTRACT**

A hierarchy of nodes is organized over levels. Each node corresponds to a configuration item. A first topology corresponds to a first model and includes at least a first subset of the hierarchy of nodes. Each node of the first topology has a first calculation unit for the first model. A second topology corresponds to a second model and includes at least a second subset of the hierarchy of nodes. Each node of the second topology has a second calculation unit for the second model.

20 Claims, 3 Drawing Sheets

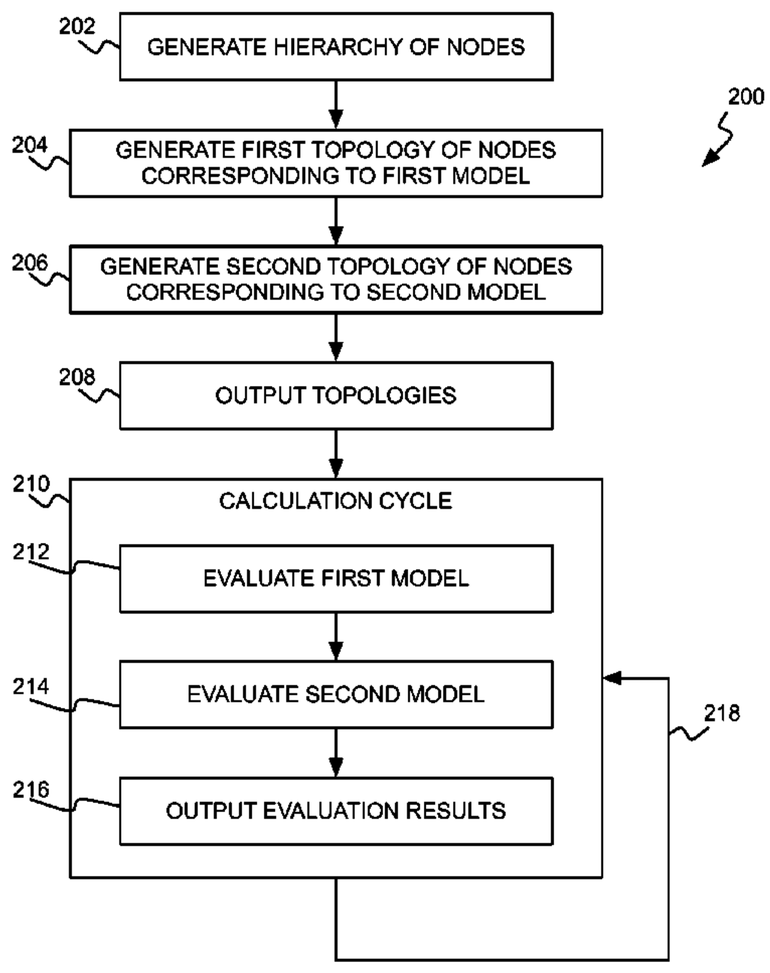
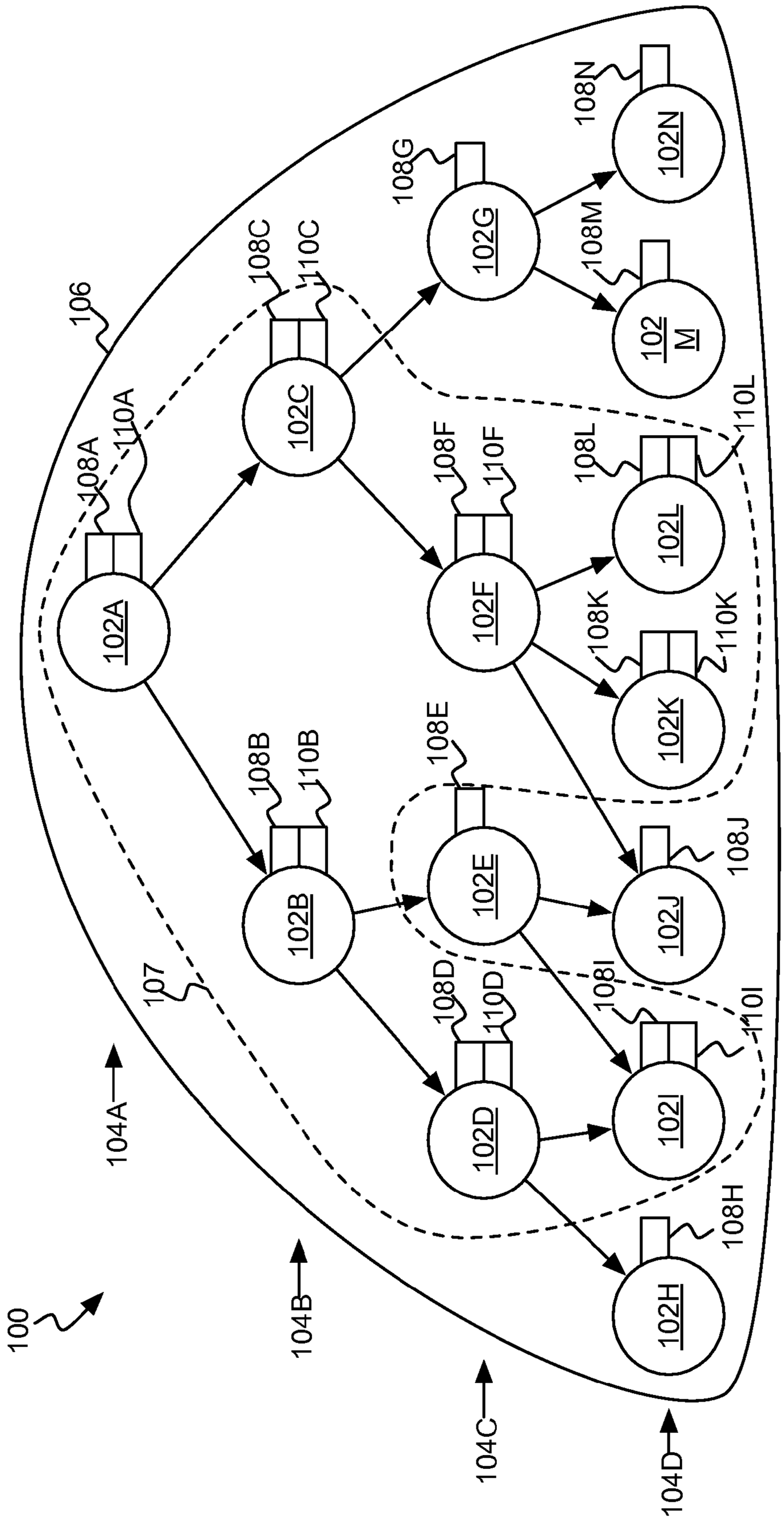


FIG 1


100
102A
102B
102C
102D
102E
102F
102G
102H
102I
102J
102K
102L
102M
102N
104A
104B
104C
104D
106
107
108A
108B
108C
108D
108E
108F
108G
108H
108I
108J
108K
108L
108M
108N
110A
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110C
110D
110F
110I
110K
110L

FIG 2

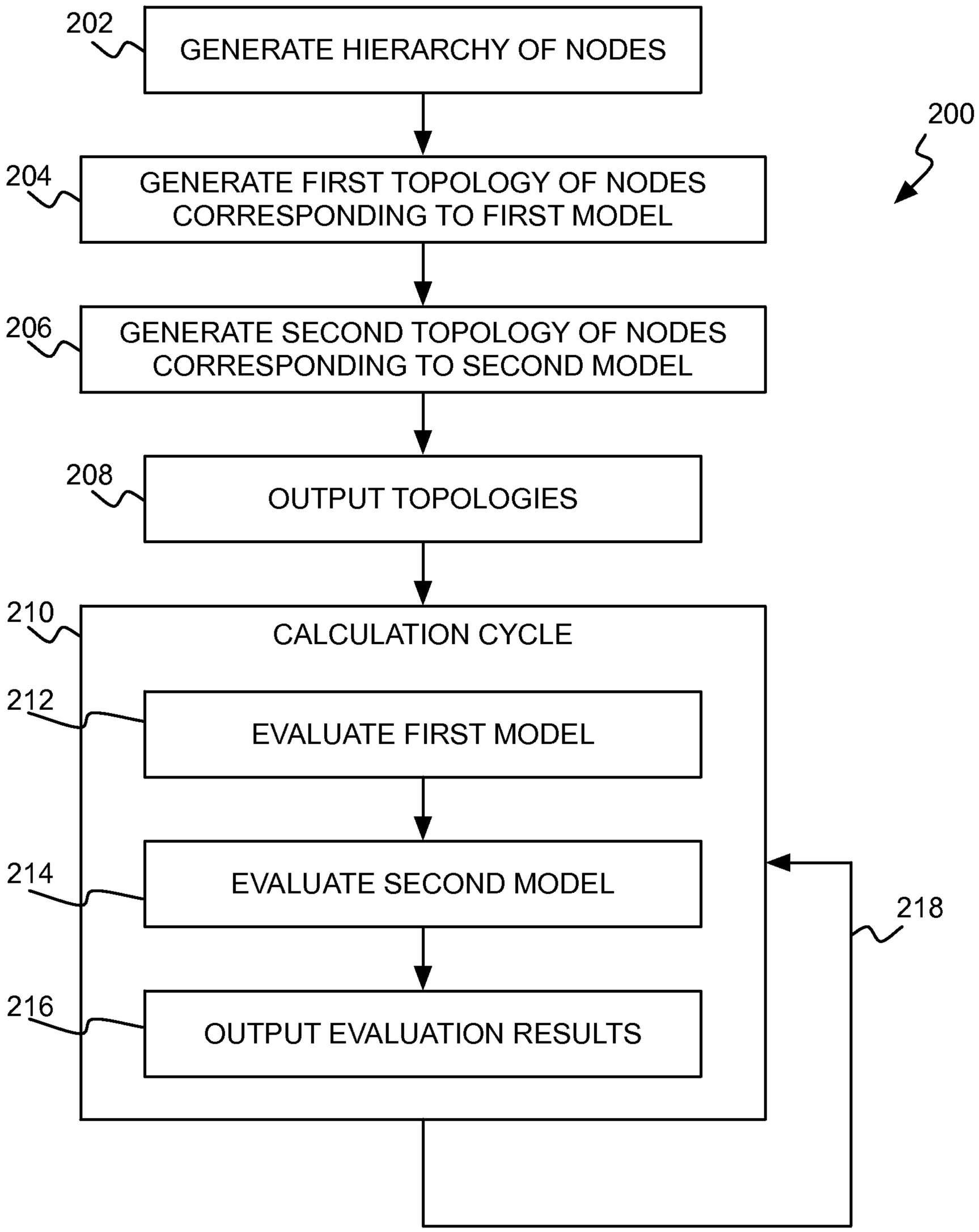
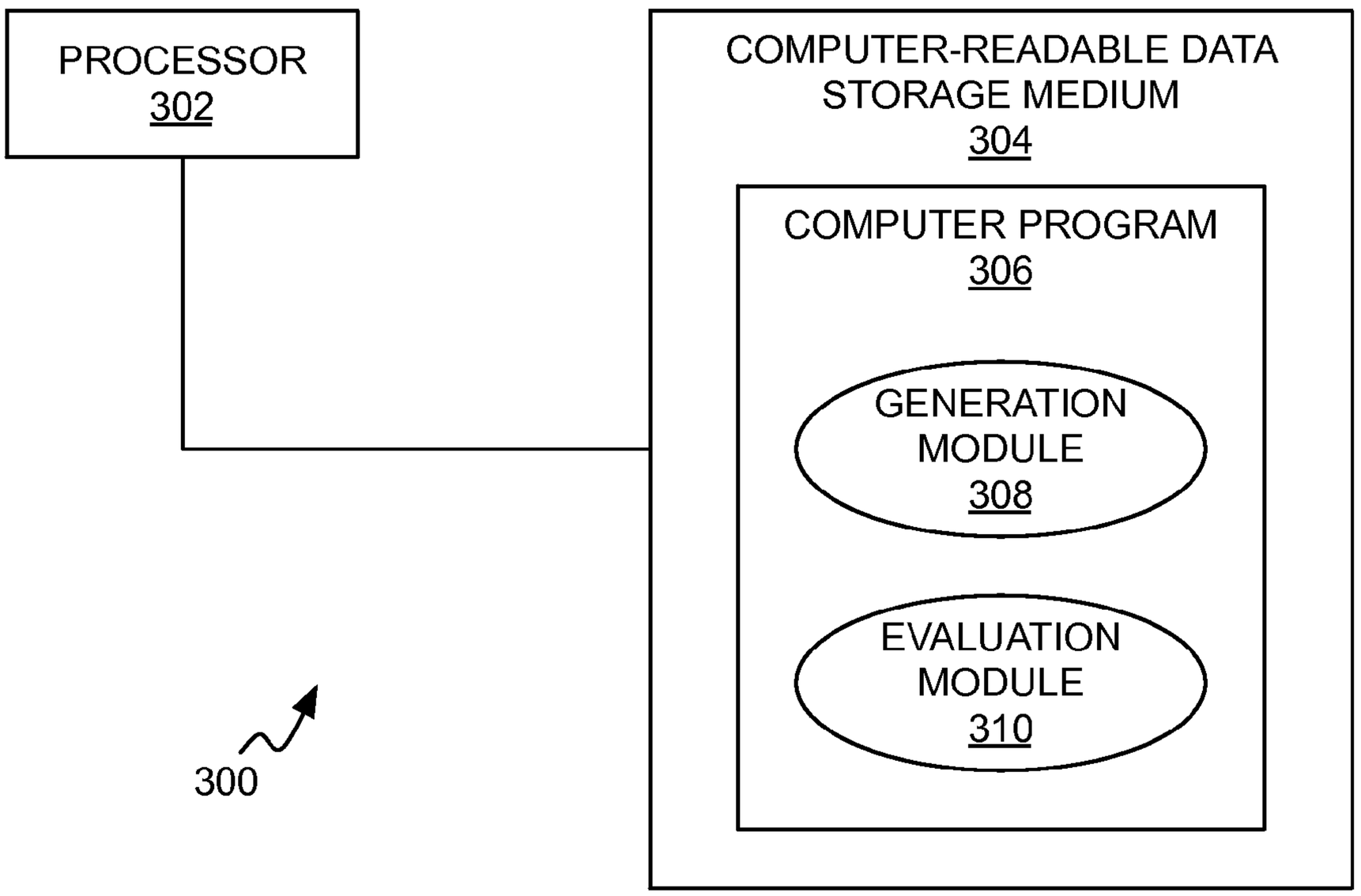

202
GENERATE HIERARCHY OF NODES
200
204
GENERATE FIRST TOPOLOGY OF NODES CORRESPONDING TO FIRST MODEL
206
GENERATE SECOND TOPOLOGY OF NODES CORRESPONDING TO SECOND MODEL
208
OUTPUT TOPOLOGIES
210
CALCULATION CYCLE
212
EVALUATE FIRST MODEL
214
EVALUATE SECOND MODEL
216
OUTPUT EVALUATION RESULTS
218

FIG 3


PROCESSOR
302
COMPUTER-READABLE DATA STORAGE MEDIUM
304
COMPUTER PROGRAM
306
GENERATION MODULE
308
EVALUATION MODULE
310
300

TOPOLOGIES CORRESPONDING TO MODELS FOR HIERARCHY OF NODES

BACKGROUND

Computing systems can be used to generate and evaluate models. For instance, one example of such a model pertains to business services management (BSM). A model pertaining to BSM may represent the underlying system that is being used to provide a particular type of business service. For example, a business service may be provided by a network of different business entities, computing devices and other computing resources that interact with one another. Evaluating the model may be accomplished to ascertain whether this underlying system is performing properly.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** is a diagram of an example hierarchy of nodes having multiple contexts corresponding to different models.

FIG. **2** is a flowchart of an example method.

FIG. **3** is a diagram of an example system.

DETAILED DESCRIPTION

As noted in the background section, models that can be generated and evaluated include models pertaining to business services management (BSM) that can represent the underlying systems that are being used to provide various business services. A model pertaining to BSM may include a hierarchy of nodes that are organized over levels. Each node corresponds to a configuration item, which may be a business entity or a different computing device or other type of computing resource of the underlying system represented by the model.

Generally a model pertaining to BSM provides for a certain perspective of looking at, and thus evaluating, the underlying system providing the business service in question. For example, one model may provide a way to determine an aggregate calculation of the average throughput of responding to a request within the system. By comparison, another model may provide a way to determine an aggregate calculation of the average load of such requests within the system.

To achieve these different perspectives, existing modeling approaches duplicate the hierarchy of nodes. Each model has a corresponding hierarchy of nodes, and is evaluated separately. However, this overall redundancy can result in increased overhead in generating, maintaining, and evaluating the models.

By comparison, disclosed herein are techniques to provide different perspectives for looking at, and thus evaluating, the underlying system providing the business service. For example, consider the case where there are two perspectives by which a particular system is to be examined and evaluated. A first topology corresponds to a first model and to a first context of the nodes, and includes a first subset of the hierarchy of nodes. A second topology corresponds to a second model and to a second context of the nodes, and includes a second subset of the hierarchy of nodes. Thus, there is no duplication of the hierarchy itself. Rather, different contexts, to which the two models correspond, are applied to the same hierarchy of nodes.

Each node of the first topology has a first calculation unit for the first model. The first context can be associated with the first calculation units of these nodes. Each node of the second topology has a second calculation unit for the second model. The second context can be associated with the second calculation units of these nodes. When the models are to be evaluated, the first and second calculation units of the first and second contexts can be evaluated within a single computational cycle, which further permits redundancy to be avoided.

FIG. **1** shows an example hierarchy **100** of nodes **102**A, **102**B, . . . , **102**N, collectively referred to as the nodes **102**, and which are organized over levels **104**A, **104**B, **104**C, and **104**D, which are collectively referred to as the levels **104**. While there are fourteen nodes **102** in the example hierarchy **100** organized over four levels **104**, this is just one example. More generally, there can be more or less nodes **102**, and more or less levels **104**.

Each node **102** within each level **104** except for the lowest level **104**D in the example hierarchy **100** refers to one or more nodes **102** within a lower level **104**. The node **102**A in the level **104**A refers to the nodes **102**B and **102**C in the level **104**B. The node **102**B refers to the nodes **102**D and **102**E in the level **104**C, whereas the node **102**C refers to the nodes **102**F and **102**G in the level **104**C. The node **102**D refers to the nodes **102**H and **102**I in the level **104**D, and the node **102**E refers to the nodes **102**I and **102**J in the level **104**D. The node **102**F refers to the nodes **102**J, **102**K, and **102**L in the level **104**D, and the node **102**G refers to the nodes **102**M and **102**N in the level **104**D.

Each node **102** corresponds to a configuration item. A configuration item is a business entity, a computing device, or another type of computing resource of an underlying system that provides a given functionality, such as BSM. For example, each configuration item may correspond to a BSM resource, which may be a business entity or a computing resource like a computing device, a database, a storage device, and so on. Different perspectives of the underlying system are provided by different models to which topologies of different subsets of the hierarchy **100** of nodes **102** correspond.

In the example of FIG. **1**, there are two example models: a first model to which a first topology **106** corresponds, and a second model to which a second topology **107** corresponds. More generally, however, there can be more than two topologies corresponding to more than two models. The first topology **106** in the example of FIG. **1** includes a first subset of the nodes **102** made up of all the nodes **102** of the hierarchy **100**. The second topology **107** includes a second subset of the nodes **102** including the nodes **102**A, **1028**, **102**C, **102**D, **102**F, **102**I, **102**K, and **102**L. The first topology **106** is represented in FIG. **1** by a solid line, whereas the second topology **107** is represented in FIG. **1** by a dashed line.

Each node **102** within the first topology **106** has a first calculation unit **108** for the first model. As such, the nodes **102**A, **102**B, **102**C, **102**D, **102**E, **102**F, **102**G, **102**H, **102**I, **102**J, **102**K, **102**L, **102**M, and **102**N have first calculation units **108**A, **108**B, **108**C, **108**D, **108**E, **108**F, **108**G, **108**H, **108**I, **108**J, **108**K, **108**L, **108**M, and **108**N, respectively, which are collectively referred to as the first calculation units **108**. Each node **102** within the second topology **107** likewise has a second calculation unit **110** for the second model. As such, the nodes **102**A, **102**B, **102**C, **102**D, **102**F, **102**I, **102**K, and **102**L have second calculation units **110**A, **1108**, **110**C, **110**D, **110**F, **110**I, **110**K, and **110**L, respectively, which are collectively referred to as the second calculation units **110**. There are no second calculation units **110** for the nodes **102** that are not part of the second topology **107**, because these nodes **102** are not considered when evaluating the second model to which the second topology **107** corresponds.

A given calculation unit of a certain node **102** for a particular model includes the computations that are performed in relation to the certain node **102** when evaluating the model.

For example, the first calculation unit **108**C of the node **102**C for the first model includes the computations that are performed in relation to the node **102**C when evaluating the first model. Likewise, the second calculation unit **110**C of the node **102** for the second model includes the computations that are performed in relation to the node **102**C when evaluating the second model.

A particular model is evaluated on a node-by-node basis from a lowest level **104** that includes nodes **102** of the topology to which the particular model corresponds, to a highest level **104** that includes nodes **102** of the topology to which the particular model corresponds. Furthermore, a given calculation unit of a certain node **102** for the particular model is evaluated based on the evaluation results of the given calculation units of the nodes **102** to which the certain node **102** refers within the hierarchy **100** and that are part of the topology to which the particular model corresponds. However, the nodes **102** to which the certain node **102** refers within the hierarchy **100** that are not part of the topology to which the particular model corresponds are not used to evaluate the given calculation unit of the certain node **102** for the particular model.

Two examples are presented to explain the foregoing. Consider the first model to which the first topology **106** corresponds. After the first calculation units **108** of the nodes **102** within the lowest level **104**D have been evaluated, the first calculation unit **108**D of the node **102**D within the level **104**C, which is also part of the first topology **106**, may be evaluated. The node **102**D refers to the nodes **102**H and **102**I, which are both within the first topology **106**. Therefore, the first calculation unit **108**D of the node **102**D is evaluated based on the evaluation results of the first calculation units **108**H and **108**I of the nodes **102**H and **102**I.

However, consider next the second model to which the second topology **107** corresponds. After the second calculation units **110** of the nodes **102** within the lowest level **104**D and that are part of the second topology **107** have been evaluated, the first calculation unit of the node **102**D within the level **104**C, which is also part of the second topology **107**, may be evaluated. Although the node **102**D refers to the nodes **102**H and **102**I, the node **102**H is not part of the second topology. Therefore, the second calculation unit **110**D of the node **102**D is evaluated based on the evaluation result of just the second calculation unit **110**I of the node **102**I.

FIG. **2** shows an example method **200**. The method **200** may be performed by a processor, such as a processor of a computing system like a computing device. The method **200** is described in relation to the hierarchy **100** of nodes **102**.

The hierarchy **100** of nodes **102** is generated (**202**). For instance, each node **102** is instantiated or created as representing or corresponding to a configuration item, and relationships among the nodes **102**, indicating which nodes **102** refer to which other nodes **102**, are also created. Via these relationships, the nodes **102** are thus organized over the levels **104**, such that the relationships in effect form the hierarchy **100**. The hierarchy **102** of nodes **102** may be generated by permitting a user to instantiate the nodes **102** and to create the relationships among of the nodes **102**, such as within a graphical user interface (GUI).

The first topology **106** of the nodes **102**, corresponding to the first model, is generated (**204**). For instance, a user may be permitted to select the subset of nodes **102** that are included within the first topology **106**. The user may further be permitted to create or instantiate the first calculation unit **108** for each such node **102** within the first topology **106**. The first calculation units **108** effectively define the first model to which the first topology **106** corresponds. In this respect, it is said that generating the first topology **106** can include generating the context corresponding to the first model, where this context is associated with the first calculation unit of each node **102** included within the first topology **106**.

The second topology **107** of the nodes **102**, corresponding to the second model, is also generated (**206**). For instance, a user may also be permitted to select the subset of nodes **102** that are included within the second topology **107**. The user may further be permitted to create or instantiate the second calculation unit **110** for each such node **102** within the second topology **107**. The second calculation units **110** effectively define the second model to which the second topology **107** corresponds. In this respect, it is also said that generating the second topology **107** can include generating the context corresponding to the second model, where this context is associated with the second calculation unit of each node **102** included within the second topology **107**.

The topologies that have been generated are output (**208**). Outputting the topologies can include storing data representing the topologies on a computer-readable data storage medium, displaying graphical representations of the topologies within a GUI, as well as transmitting the data representing the topologies over a network. It is noted that redundancy is avoided even though there are two models, because the hierarchy **100** of nodes **102** is shared by both the first topology **106** and the second topology **107**. That is, the contexts corresponding to the models are each associated with the same hierarchy **100** of nodes **102**, and not with different hierarchies of nodes.

The following may be periodically performed, such as during each single calculation cycle of a number of such calculation cycles that occur over time (**210**). The first model is evaluated by evaluating the first calculation unit **108** of each node **102** of the first topology **106** (**212**), such as on a node-by-node basis from the lowest level **104** to the highest level **104** that includes a node **102** of the first topology **106**, as described above. Likewise, the second model is evaluated by evaluating the second calculation unit **110** of each node **102** of the second topology **107** (**214**), such as on a node-by-node basis from the lowest level **104** to the highest level **104** that includes a node **102** of the second topology **107**, as also described above.

Results of the evaluations of the models can be output (**216**), in the same manner as the topologies **106** and **106** themselves were output in part **208**. It is noted that the evaluations of parts **212** and **214** can occur within a single calculation cycle, which aids in avoiding redundancy in evaluating the models. The method **200** can be periodically repeated at least at part **210**, as indicated by the arrow **218**.

FIG. **3** shows an example system **300**. The system **300** may be implemented over one or more computing devices, which may be interconnected to one another over a network. The system **300** includes at least a processor **302** and a computer-readable data storage medium **304**. The system **300** can include other components as well, in addition to the processor **302** and the computer-readable medium **304**. Examples of computer-readable media include volatile and non-volatile media, such as hard disk drives and other types of magnetic media, optical discs and other types of optical media, semiconductor memory and other types of semiconductor media, and so on.

The computer-readable data storage medium **304** stores a computer program **306**. The computer program **306** is executable by the processor **302**. The computer program **306** can include two modules: a generation module **308** and an evaluation module **310**. The generation module **308** generates the hierarchy of nodes **102** and the topologies **106** and **107**, and as

such can perform parts **202**, **204**, **206**, and **208** of the method **200**. The evaluation module **310** evaluates the models to which the topologies **106** and **107** correspond, and as such can perform parts **210**, **212**, **214**, **216**, and **218** of the method **200**.

The extension of a hierarchy **100** of nodes **102** to multiple topologies **106** and **107**, via corresponding calculation units **108** and **110**, has been described at least in some part in relation to underlying systems for which models pertaining to BSM are evaluated. However, the disclosed extension can be applied to other types of models as well. Examples of such other types of models include traffic models, water management models, as well as other types of models.

We claim:

1. A method comprising:

generating, by a processor of a computing device, a hierarchy of nodes organized over a plurality of levels, each node corresponding to a configuration item, the nodes corresponding to computing resources of a system, the computing resources interacting with one another to provide a business service of the system;

after generating the hierarchy of nodes, generating, by the processor, a first topology corresponding to a first model, including identifying which of the nodes of the hierarchy to define the first topology as a first subset of the hierarchy of nodes, each node of the first topology having a first calculation unit for the first model, the first topology comprising the nodes of the first subset; and,

after generating the hierarchy of nodes, generating, by the processor, a second topology using a same hierarchy as was used to generate the first topology, the second topology different than the first topology, corresponding to a second model different than the first model, including identify which of the nodes of the hierarchy to define the second topology as a second subset of the hierarchy of nodes different than the first subset, each node of the second topology having a second calculation unit for the second model, the second topology comprising the nodes of the second subset;

outputting, by the processor, the first topology and the second topology; and

determining whether the system is performing properly to provide the business service by evaluating the first model using the first topology and the second model using the second topology, including evaluating the first calculation units of the first topology and the second calculation units of the second topology within a single computational cycle,

wherein generating the first topology and the second topology from the same hierarchy avoids duplication between the first topology and the first hierarchy and reduces overhead in generating the first topology and the second topology,

and wherein evaluating the first calculation units and the second calculation units within the single computational cycle reduces redundancy in determining whether the system is performing properly.

2. The method of claim **1**, wherein one or more given nodes of the hierarchy are part of both the first topology and the second topology, such that each given node has a first calculation unit for the first model and a second calculation unit for the second model.

3. The method of claim **1**, wherein the first topology is different than the second topology, the first model is different than the second model, and the first subset is different than the second subset.

4. The method of claim **1**, wherein each node of each level of nodes except for a lowest level refers to one or more nodes of the levels that are lower than the level of the node.

5. The method of claim **1**, wherein one or more of:

generating the hierarchy of nodes comprises permitting a user to instantiate each node, and to create relationships of the nodes, the relationships forming the hierarchy;

generating the first topology comprises permitting the user to select the first subset of the hierarchy of nodes, and to create the first calculation unit for each node of the first topology;

generating the second topology comprises permitting the user to select the second subset of the hierarchy of nodes, and to create the second calculation unit for each node of the second topology.

6. The method of claim **1**, wherein generating the first topology comprises generating a first context corresponding to the first model, the first context associated with the first calculation unit of each node of the first subset,

and wherein generating the second topology comprises generating a second context corresponding to the second model, the second context associated with the second calculation unit of each node of the second subset.

7. The method of claim **6**, wherein redundancy is avoided due to the hierarchy of nodes being shared by both the first topology and the second topology, such that the first context and the second context are both associated with the hierarchy of nodes and not with different hierarchies of nodes.

8. The method of claim **1**, further comprising, within a single calculation cycle:

evaluating, by the processor, the first model by evaluating the first calculation unit of each node of the first topology;

evaluating, by the processor, the second model by evaluating the second calculation unit of each node of the second topology; and,

outputting results of evaluating the first model and the second model.

9. The method of claim **8**, wherein redundancy in evaluating the first model and the second model is avoided due to the hierarchy of nodes being shared by both the first topology and the second topology.

10. The method of claim **1**, wherein each of the first model and the second model corresponds to a different business services management model for the hierarchy of nodes,

and wherein the configuration node to which each node corresponds comprises a different business services management resource that is used in the different business services management model to which each of the first model and the second model correspond.

11. A non-transitory computer-readable data storage medium storing a computer program executable by a processor to perform a method comprising:

evaluating a first model to which a first topology corresponds, the first topology comprising and defined as a first subset of a hierarchy of nodes and generated after the hierarchy of nodes was generated, the hierarchy of nodes organized over a plurality of levels, each node of the hierarchy corresponding to a configuration item, each node of the first topology having a first calculation unit for the first model, the nodes corresponding to computing resources of a system, the computing resources interacting with one another to provide a business service of the system, wherein evaluating the first model includes evaluating the first calculation nodes within a single computational cycle;

evaluating a second model to which a second topology corresponds, the second topology comprising and defined as a second subset of the hierarchy of nodes, generated after the hierarchy of nodes was generated, and generated using a same hierarchy as the first topology uses, each node of the second topology having a second calculation unit for the second model, the second topology different than the first topology, the second model different than the first model, the second subset different than the first subset, wherein evaluating the second model includes evaluating the second calculation nodes within the single computational cycle;

outputting results of evaluating the first model and the second model; and

determining whether the system is performing properly to provide the business service using the results,

wherein the first topology and the second topology being generated from the same hierarchy avoids duplication between the first topology and the first hierarchy and reduces overhead when the first topology and the second topology are generated,

and wherein evaluating the first calculation units and the second calculation units within the single computational cycle reduces redundancy in determining whether the system is performing properly.

12. The non-transitory computer-readable data storage medium of claim **11**, wherein the first model and the second model are each evaluated within a single calculation cycle, such that redundancy is avoided due to the hierarchy of nodes being shared by both the first topology and the second topology.

13. The non-transitory computer-readable data storage medium of claim **11**, wherein evaluating the first model comprises evaluating the first calculation unit of each node of the first topology,

and wherein evaluating the second model comprises evaluating the second calculation unit of each node of the second topology.

14. The non-transitory computer-readable data storage medium of claim **13**, wherein evaluating the first calculation unit of each node of the first topology comprises evaluating the first calculation units of the nodes of the first topology on a node-by-node basis from a lowest level of the hierarchy of nodes to a highest level of the hierarchy of nodes,

and wherein evaluating the second calculation unit of each node of the second topology comprises evaluating the second calculation units of the nodes of the second topology on a node-by-node basis from the lowest level of the hierarchy of nodes to the highest level of the hierarchy of nodes.

15. A system comprising:

a processor; and,

a computer-readable data storage medium to store a computer program executable by the processor,

wherein the computer program is to:

generate a first topology corresponding to a first model, including identifying which of a plurality of nodes of a hierarchy to define the first topology as a first subset of the hierarchy of nodes, after the hierarchy is generated, and generating a second topology corresponding to a second model, including identifying which of the nodes of the hierarchy to define a second subset of the hierarchy of nodes, the hierarchy after the hierarchy is generated, the second topology generated using a same hierarchy as was used to generate the first topology, the second topology different than the first topology, the second subset different than the first subset, the second model different than the first model, the nodes corresponding to computing resources of a business system, the computing resources interacting with one another to provide a business service of the business system, the first topology comprising the nodes of the first subset, the second topology comprising the nodes of the second subset;

evaluate the first model and the second model to generate evaluation results, including evaluating the first calculation units of the first topology and the second calculation units of the second topology within a single computational cycle; and

determining whether the business system is performing properly to provide the business service using the evaluation results,

wherein the hierarchy of nodes is organized over a plurality of levels, each node of the hierarchy corresponding to a configuration item, each node of the first topology having a first calculation unit for the first model, each node of the second topology having a second calculation unit for the second model,

wherein generating the first topology and the second topology from the same hierarchy avoids duplication between the first topology and the first hierarchy and reduces overhead in generating the first topology and the second topology,

and wherein evaluating the first calculation units and the second calculation units within the single computational cycle reduces redundancy in determining whether the business system is performing properly.

16. The method of claim **1**, wherein redundancy in evaluating the first model and the second model is avoided due to the hierarchy of nodes being shared by both the first topology and the second topology.

17. The method of claim **1**, wherein the first subset of the hierarchy of nodes of the first topology and the second subset of the hierarchy of nodes of the second topology are overlapping, non-identical subsets of the hierarchy of nodes.

18. The method of claim **17**, wherein each node of the hierarchy of nodes that is present both in the first subset of the first topology and in the second subset of the second topology has both the first calculation unit for the first model and the second calculation unit for the second model.

19. The method of claim **18**, wherein each node of the hierarchy of nodes that is present just in the first subset of the first topology and not in the second subset of the second topology has the first calculation unit for the first model and not the second calculation unit for the second model.

20. The method of claim **19**, wherein each node of the hierarchy of nodes that is present just in the second subset of the second topology and not in the first subset of the first topology has the second calculation unit for the second model and not the first calculation unit for the first model.

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